SIDDIQUI, M.Q., BROWN, J.F. and ALLEN, S.J. 1975. Growth stages of sunflower and intensity indices for white blister and rust. *Plant Disease Reporter.* 59, 7 — 11.

SINGH, J.F. 1975. Field evaluation of fungicides for the control of sunflower rust in Kenya. *Plant Disease Reporter.* 59, 200 — 202.

SOOD, P.M. and SACKSTON, W.E. 1970. Studies on sunflower rust VI: Penetration and infection of sunflowers susceptible and resistant to *Puccinia helianthi.* race I. *Canadian Journal of Botany.* 48, 2179 — 2181.

SOOD, P.N. and SACKSTON, W.E. 1972. Studies on sunflower rust XI: Effect of temperature and light on germination and infection of sunflowers by *Puccinia helianthi.* race I: *Canadian Journal of Botany.* 50, 1879 — 1886.

STOVOLD, G.E. and MOORE, K.J. 1972. Oilseed sunflowers: diseases. *New South Wales Agricultural Gazette.* 83, 262 — 264.

ZIMMER, D.E. and HOES, J.A. 1978. Diseases. In *Sunflower science and technology.* p 225 — 262. American Society of Agronomy, Madison.

INVESTIGATIONS INTO INCREASED RUST *(PUCCINIA HELIANTHI)* INTENSITY ON SOME HYBRID SUNFLOWER CULTIVARS GROWN IN QUEENSLAND.

J.K. KOCHMAN and K.C. GOULTER
Department of Primary Industries, P.O. Box 102, Toowoomba, Qld, 4350, Australia.

ABSTRACT

Rust *(Puccinia helianthi)* intensity measured in crops of a number of hybrid cultivars grown in Queensland during 1980 and 1981 ranged from 30 to 60% of leaf area. In previous years these cultivars had a good level of resistance with rust ratings of 2 — 5% being usual. A set of differential lines, a number of open-pollinated and inbred lines and a range of commercial hybrids were inoculated with uredospores collected during both seasons from these and crops of open-pollinated cultivars as well as with uredospores collected during previous seasons. Because of the resistant reactions obtained on differentials with the resistance gene R1, all the collections could be allocated to race group 1. However, a differential line (supposedly containing resistance genes R1 and R2) was more susceptible to the rust from hybrids in 1980 and 1981 than to the other collections. Data recorded from the other lines and cultivars were somewhat variable. On some lines and cultivars either no pustules were produced, or the pustules were very small in size and number. On cultivars where rust developed the isolate collected from hybrids produced equal generation times on the hybrids Hysun 31, Sunace and, Suncross 52, and on the open-pollinated cultivars tested, whereas generation time was significantly shorter on open-pollinated cultivars than on these hybrids for the isolate from collections prior to 1980. Both isolates generally produced more and larger pustules on the open-pollinated cultivars than on the hybrids, but the differences appeared to be smaller with the 1980 isolate from hybrids than the other isolate.

INTRODUCTION

Hybrid sunflower cultivars with resistance to rust *(Puccinia helianthi* Schw.*)* became available in Australia during the early nineteen seventies and have become widely accepted and grown by farmers. Because of the nature and selection of parental lines and the involvement of private seed companies in production of hybrid cultivars, there is some uncertainty as to which genes for rust resistance are present in the various hybrids available. The first cultivars released were immune to rust with resistance apparently conferred by the R1 gene. Subsequently other cultivars were released which took some rust under the local conditions, but typical ratings were in the order of 2 — 5% of leaf area. Resistance in some of these cultivars may have been conferred by the R2 gene.

During 1980 and 1981 several crops of the latter type hybrids in southern Queensland were found with 30 — 60% of their leaf area covered by rust pustules. The levels of rust in these hybrids were of great concern to the sunflower industry in Queensland because it had been shown that control of severe epidemics in open-pollinated cultivars increased yield by about 70% (Middleton and Obst, 1972; Brown *et al.,* 1974).

Studies were conducted to determine the reasons for the increased incidence of rust in some of these hybrids and the results are reported and discussed in this paper.

MATERIALS AND METHODS

Uredospores were collected from crops of open-pollinated and hybrid cultivars either with a large spore collector (Cherry and Peet, 1966) or by scraping uredospores from infected leaves in the laboratory. Single spores were taken from these collections and increased on a very susceptible cultivar (either cv. Polestar or cv. Sunfola 68-2). Portions of the bulk collections were stored in liquid nitrogen for future reference.

The race group of the isolates was determined on a set of seven differentials. These were: S37-388 ("universal suscept"), S37-388 RR (R1 gene), 69-17-8-1-1 (R1 gene), 29-3-1-3-2-1 (R2 gene), 953-102-1-1-41 (R1 and R2 genes), 953-88-3-1-54 (original source of rust resistance) and, Polestar (rust susceptible birdseed cultivar). With the exception of Polestar all the other lines were imported from Canada. Information from several sources (Sackston, pers. comm.; Sackston, 1962; Jabbar Miah and Sackston, 1970) was used to identify the genes for rust resistance supposedly carried by the various lines. Plants were inoculated as seedlings with four replicates of each being used to determine reaction type. If the reactions were not equivalent on all plants of a particular line, isolates were retyped on 10 replicates. Reaction types of each isolate were rated 14 days after inoculation on a 0 — 4 basis (Sackston, 1962) with 0, 1 and 2 considered resistant and 3, 4 susceptible. All rust typing was done under uniform conditions in controlled environment cabinets set at 18/22 $\pm$ 1°C night/day and 600 μ E m^{-2} sec^{-1} (measured by a Lambda Li-170 quantum/radiometer/photometer) supplied in 12 h photoperiods.

The macroscopic development of two rust isolates (one collected during 1979 and the other collected from hybrids during 1980) was observed on the following lines and cultivars: RHA 266, RHA 274, cms HA 89, Polestar (open-pollinated), Sunfola 68-2 (open-pollinated), Hysun 30 (hybrid), Hysun 31 (hybrid), Suncross 52 (hybrid) and, Sunace (hybrid). Seedlings of these lines were uniformly inoculated with uredospores, incubated and grown in the same controlled environment conditions used for rust typing. Data collected were; generation time (days from inoculation to pustule eruption), pustule number, pustule diameter and reaction type (the last three at 14 days after inoculation). Ten replicates with two plants per replicate were used in each experiment. Pustule diameter was determined by measuring 20 pustules in each replicate, but all pustules were measured

on those cultivars where fewer than 20 pustules developed. These experiments were repeated four times.

Rust inoculations were performed as follows. Discs of germination paper (20 mm diameter, 1.5 mm thick) were dusted uniformly in a spore settling tower (Brown and Kochman, 1973) with dry rust uredospores. Twenty mg of spores were used in each inoculation. The paper discs were attached, dusted surface in contact with the leaf, to the adaxial surface of the first or second true leaf of the sunflower seedling with paper clips. After each disc was moistened with water it acted as a humidity chamber for the uredospores. Inoculated seedlings were kept in darkness for 16 h at 21 ± 1°C. The discs were then removed and plants grown under controlled environment conditions.

Analysis of variance was performed on all data and least significant differences determined.

RESULTS

Reaction of differential lines to rust isolates.

The resistant reaction of differentials (Table 1) carrying the R1 gene indicated that all isolates were in race group 1. However, both 953-102-1-1-41 and 953-88-3-1-54 were more susceptible to isolates collected from hybrid cultivars during 1980 — 81 than to those collected in 1979 and those from open-pollinated crops.

Table 1. A comparison of reactions of differential lines to rust isolates collected from all crops during 1979 and open-pollinated crops during 1980/81 and isolates collected from hybrids during 1980 and 1981.

Differential lines	Reaction types*	
	Isolates collected during 1979 and from open-pollinated crops during 1980/81.	Isolates collected from hybrid crops during 1980/81.
Polestar	4	4
S37-388	4	4
S37-388 RR (R1 gene)	0	0
69-17-18-1-1 (R1 gene)	0	0
29-3-1-3-2-1 (R2 gene)	0	0
953-102-1-1-41 (R1 + R2 gene)	1	2 — 3
953-88-3-1-54 (original source of resistance)	1	2 — 3

*Reaction types 0, 1, 2 considered to be resistant and 3 and 4 considered to be susceptible.

Development of two rust isolates on nine lines and cultivars.

The reaction type, generation time, pustule number and pustule size of each isolate on the various lines and cultivars are listed in Table 2.

The various reaction types of each isolate were equivalent on each cultivar tested except on Hysun 30 where the 1979 isolate gave 0; −1 reaction and the 1980 isolate from hybrids gave a 0; (fleck) reaction.

The 1979 isolate produced no pustules on RHA 266 and only a few very small pustules on Hysun 30, whereas the 1980 isolate produced no pustules on either line. In general on the lines where rust developed, generation time of the 1979 isolate was significantly shorter (P = 0.05) on the open-pollinated cultivars than on the hybrids. With the 1980 isolate generation times were short and not significantly different (P = 0.05) on both open-pollinated and hybrid cultivars. There were significant differences (P = 0.05) in pustule number and pustule size produced by both isolates on the various lines and cultivars, with generally more and larger pustules on the open-pollinated cultivars than on hybrids. Overall, it appeared the generation time for the 1980 isolate was shorter and pustule number and diameter greater with the 1980 isolate than the 1979 isolate.

Table 2. A comparison of reaction type, generation time, pustule number, pustule size, produced by two *Puccinia helianthi* isolates on nine sunflower lines and cultivars.

Live or Cultivar	Isolate collected in 1979				Isolate collected from hybrids during 1980			
	Reaction type	Generation time (days)	Pustule Number	Pustule Diameter (mm)	Reaction type	Generation time (days)	Pustule Number	Pustule Diameter (mm)
RHA 266	0;	No pustules formed			0;	No pustules formed		
RHA 274	2 — 3	8.75a	22.6cd	0.15c	2 — 3	8.26a	26.6c	0.21e
cms HA 89	4	7.0d	119. a	0.24c	4	7.4b	45.5c	0.38c
Polestar (O.P)	4	8.25c	87.4b	0.41a	4	7.14b	82.7a	0.49a
Sunfola 68-2 (O.P)	4	7.25d	39.8c	0.37a	4	6.98b	74.6ab	0.44b
Hysun 30 (hybrid)	0; −1	13.75a	1.4d	0.03e	0;	No pustules formed		
Hysun 31 (hybrid)	3 — 4	8.75b	19.3cd	0.17d	3 — 4	7.4b	32.0c	0.42bc
Suncross 52 (hybrid)	3 — 4	8.75b	38.6c	0.30b	3 — 4	7.3b	50.8bc	0.42bc
Sunace (hybrid)	3 — 4	9.0b	29.5cd	0.25bc	3 — 4	7.2b	47.5c	0.30d

1. Values in each column followed by the same letters do not differ significantly (P = 0.05).

DISCUSSION

Although all rust isolates typed in this study produced a resistant reaction on the differential lines containing the R1 gene, and could therefore be allocated to race group 1, the isolates collected from race group 1 in 1980 — 81 did behave differently to the other isolates. Firstly the isolates collected prior to 1980 produced a 1 reaction on the 953 differentials whereas the isolates collected from hybrids in 1980 — 81 produced a 2 — 3 reaction on these lines. Secondly, the isolate from collections prior to 1980 had larger generation times and produced smaller and fewer pustules on the hybrids Hysun 31, Suncross 52 and Sunace, than on the rust susceptible open-pollinated cultivars. However, the generation time of the isolate collected from hybrids in 1980 was equivalent on these three hybrids and on the open-pollinated cultivars. There were still some differences in pustule size and number on various cultivars with the latter isolate.

The behaviour of the isolates from hybrids on the 953 differentials was unexpected, although other workers (Jabbar Miah and Sackston, 1970) have also reported unexpected results with rust isolates on differential lines. We have further experiments underway to determine why these lines with supposedly two genes (R1 and R2) for rust resistance are more susceptible than those lines with one gene for resistance.

Results of these studies may be very useful to plant breeding programmes, particularly those which pyramid resistance genes to maintain or improve resistance.

We realize that generation time, pustule number and pustule size of rust can be varied by a number of factors including climate, uredospore and plant age and uredospore density on leaves. However, the data we obtained in controlled conditions indicate that the isolate from collections prior to 1980 would develop more slowly on the hybrids Hysun 31, Suncross 52 and Sunace than on the open-pollinated cultivars Polestar and Sunfola 68-2. Therefore, in the field, we would expect a lower intensity of rust on these hybrids than on the open-pollinated cultivars. With the isolate collected from hybrids in 1980, we would expect that rust development would be fairly similar on these three hybrids and the open-pollinated cultivars, and that rust intensities on these cultivars in the field, would be similar. Whether yield loss caused by the rust on these hybrids is equivalent to that on open-pollinated cultivars, has yet to be determined and is currently being investigated.

Hence there is some evidence that the increased intensity of rust on some hybrid cultivars in Queensland may be due to a change in the rust population. This new population is more aggressive on these hybrid cultivars but other hybrid cultivars are still highly resistant to it. With our current differentials it is not possible to differentiate this population from race group 1. More work is required to elucidate some of the questions that this research has posed.

ACKNOWLEDGEMENTS

We wish to thank the Australian Oilseeds Research Committee who provided funds for this research.

LITERATURE CITED

BROWN, J.F., KAJORNCHAIYAKUL, P., SIDDIQUI, M. and ALLEN, S.J. 1974. Effects of rust on growth and yield of sunflower in Australia. *Proceedings of the Sixth International Sunflower Conference, Bucharest,* 639 — 646.

BROWN, J.F. and KOCHMAN, J.K. 1973. A spore settling tower for uniform inoculation of leaves with rust urediniospores. *Australian Plant Pathology Society Newsletter* 2, 26 — 27.

CHERRY, E. and PEET, C.E. 1966. A efficient device for the rapid collection of fungal spores from infected plants. *Phytopathology* 56, 1102 — 1103.

JABBAR MIAH, M.A. and SACKSTON, W.E. 1970. Genetics of rust resistance in sunflowers. *Phytoprotection* 51, 1 — 16.

MIDDLETON, K.J. and OBST, N.R. 1972. Sunflower rust reduces yield. *Australian Plant Pathology Society Newsletter* 1, 18.

SACKSTON, W.E. 1962. Studies on sunflower rust. III. Occurrence, distribution and significance of races of *Puccinia helianthi* Schw. *Canadian Journal of Botany* 40, 1449 —1458.

OCCURRENCE OF SUNFLOWER DISEASES IN PORTUGAL IN THE LAST FOUR YEARS (1978 — 1981).

MAUD L. de BARROS

Missao de Estudos Agronomicos do Ultramar (JICU), Ap. 3014, 1301 Lisboa Codex, Portugal.

ABSTRACT

Symptoms of head rot *(Rhizopus arrhizus)*, gray rot *(Botrytis cinerea)*, white rot *(Sclerotinia sclerotiorum)*, leaf spot *(Alternaria* sp.*)*, collar rot *(Fusarium* sp. and *Sclerotium rolfsii)*, rust *(Puccinia helianthi)*, wilt *(Fusarium oxysporum)* and head drop *(undetermined)* on different stages of sunflower development are described, as well as their intensity of occurrence in the growing seasons of 1978 — 1981. The most harmful parasites in Portugal were *R. arrhizus* in 78 — 79 and *F. oxysporum* during 80 — 81. Satisfactory results have been achieved using different methods of inoculation of *R. arrhizus* in greenhouse. Pathogenecity tests were also undertaken for *B. cinerea* and *F. oxysporum* under greenhouse conditions.

INTRODUCTION

Sunflower growing areas in Portugal are mainly situated in the Alentejo and Ribatejo regions and the cultivars mostly used are Smena, Peredovik and also some spanish hybrids. From field surveys undertaken during the growing seasons of 1978 — 1981, a number of diseases have been reported and most of the causal organisms identified (Barros, 1978, 1980). This paper presents the results of the field surveys during the last four years and Table 1, summarizes sunflower diseases in Portugal and their occurrence.

DISEASES

Head rot *(Rhizopus arrhizus* Fisher*)*, appears as a brown spot on the back of the flowering and ripening heads, spreading rapidly as a soft rot. We began the study of this disease in 1977 and we consider it as a first record for Portugal (Barros, 1980). It was firstly observed at Elvas and Beja (Alentejo) and Vila Franca de Xira (Ribatejo). Intensity of infection was of medium attack (2)* during 1978 and 1979, being in regression — weak attack in 1980 and scarce in 1981.

Gray rot *(Botrytis cinerea* Pers. ex Pers.*)*, was observed attacking young sunflowers before budding at Alcacer do Sal (Alentejo), 1978 — weak to medium attack — and at Evora and Elvas, later in the same year attacking the base of the stem of older sunflowers. Symptoms observed were of typical gray rot, showing a velvet gray mass of conidia. Scarce in 1980.

White rot *(Sclerotinia sclerotiorum* (Lib.) De By.*)*, observed in 1977 in the Alentejo (Evora and Arraiolos), showing some importance — weak attack — at Vila Franca de Xira (1978), where we could observe well developed plants completely destroyed, presenting a rot at collar and stem zones with cellulosic tissues entirely destroyed. Large and irregular sclerotia and the presence of mycelium were observed in the fields. Scarce in 1980 and not observed during 1981.

Leaf spot *(Alternaria* sp.*)*, observed only on old leaves and sepals. Weak occurrence of no economic importance.

Collar rot *(Fusarium* sp.*)*, inducing a constriction at the base of the stem, observed at Vila Franca de Xira (1977), Alcacer do Sal (1978), Elvas (1977 and 1978) — weak occurrence — and not detected during 1980 and 1981. A different collar rot presenting an external white mycelium, due to *Sclerotium rolfsii* Sacc. was recorded for the first time at Elvas in 1978. Incidence scarce.

Rust *(Puccinia helianthi* Schw.*)* was recorded for the first time on *Helianthus annuus* L. in Portugal in 1976 (Dias & Lucas, 1978) but reporting only the urediniospores. Teliospores were observed and described for the first time in Portugal — Beja and Ferreira do Alentejo, 1979 — (Barros, 1980)